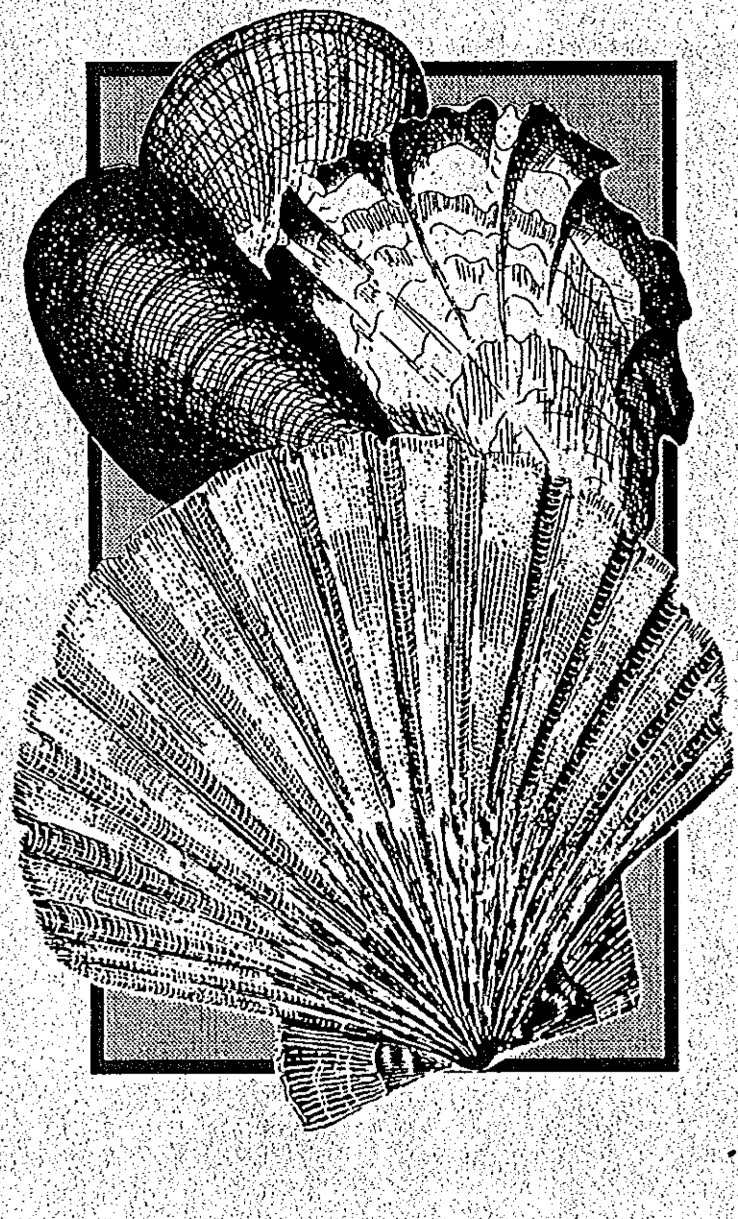
SHELLFISH FARMING AND THE ENVIRONMENT IN SCOTLAND

February 1992



A Review by Sean Meikle and Rosalind Spencer
for Scottish Wildlife and Countryside Link

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Scottish Wildlife and Countryside Link was formed in February 1987 as an association of voluntary bodies concerned with wildlife and countryside conservation in Scotland. Its purpose is to provide a forum to help its member organisations bring together their views on issues affecting mutual interests.

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Preface

This paper describes the shellfish farming industry in Scotland, assesses its environmental impact and proposes measures for improvement where appropriate.

It complements an earlier Discussion Paper dealing mainly with the salmon farming industry published by Scottish Wildlife and Countryside Link (SWCL) in March 1988, *Marine Fishfarming in Scotland*, and its subsequent *Review*, published in October 1990.

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(Shellfish illustrations by Rosalind Spencer)

Summary and Main Recommendations

1. General

Shellfish farming is well suited to the environmental and socio-economic conditions of the North and West of Scotland.

Despite its scattered nature shellfish farming is becoming a sizeable industry in the Scottish Highlands and Islands, worth around £1 million per annum. A combination of attractive financial incentives and ideal environmental conditions stimulated a significant increase in production and resulting employment during the 1980s.

The control of development is the responsibility of the Crown Estate Commissioners. As landlord of the seabed, the Crown Estate issues leases for shellfish farms, operating the same consultation procedure for lease applications as applies to salmon farms (SWCL 1988). A total of 442 shellfish farm applications has been received (to 30.6.91) for Scottish coastal waters. Of these applications, 278 were approved, 84 were rejected, 76 were withdrawn and 4 were under consideration.

As producer confidence grows, market demand improves, and economies of scale increase efficiency, shellfish farming could become a prime sector for development, given support with marketing and movement of stocks. Some finfish farming companies are beginning to diversify and make large scale investments in shellfish cultivation.

In terms of environmental impact shellfish farming is relatively benign. Unlike salmon farming it requires no inputs of enriching foods or polluting chemicals. However, there are a number of environmental concerns which should be closely monitored and further investigated.

Main Recommendation

- **Although shellfish farming is not at present covered by the EC Directive on Environmental Assessment (85/337/EEC), a full assessment of environmental impact should be mandatory before shellfish developments on coastal Sites of Special Scientific Interest and Special Protection Areas are allowed to proceed.**

2. Species Farmed

The Pacific Oyster, Common or Blue Mussel, and the King and Queen Scallop are the major species of shellfish cultivated in Scotland. However, interest is already extending to other species including the Manila Clam and lobster.

3. Landscape Effects

Shellfish farming operations are at present relatively small scale. Rafts, longlines, and trestles generally have less scenic impact than finfish farm cages. However, shellfish cultivation in the intertidal zone could have a significant scenic impact, not being at present governed by adequate guidelines. Lease conditions relating to siting and design are not properly monitored or enforced, which can result in substandard developments.

Main Recommendations

- **Before intertidal cultivation of shellfish develops on a commercial scale, guidelines on scale, siting and design should be established.**
- **Monitoring procedures should be improved in order to enforce the conditions relating to design imposed by sea bed lease agreements.**

4. Disease

The majority of Scottish sea lochs are free from pests and diseases affecting shellfish, but the spread of disease through stock movements remains a risk to both wild and farmed shellfish. EC Directive 91/67/EEC concerning the animal health conditions governing the placing on the market of aquaculture animals and products is designed to control the movement of live shellfish and spread of disease, but does not relate to pests.

Filter-feeding bivalves concentrate viruses and bacteria from the surrounding waters in their tissues. Where the growing waters are polluted this can present a public health risk. EC Draft Directive COM(89)648 laying down health conditions for the production and placing on the market of live bivalve molluscs, will come into force in January 1993.

Main Recommendation

- **It is imperative that disease transfer, both into Scotland and within Scotland, is prevented by good, informed management practice and clear and effective legislation.**

5. Introduction of Non-Native Species

The introduction of non-native shellfish species into Scotland creates the risk of their uncontrolled spread causing serious disruption of native communities. They may also introduce alien shellfish diseases.

Main recommendations

- Appropriate licensing should be strictly imposed to control the spread of introduced shellfish species and any associated disease and pests.
- Commercial scale farming of introduced shellfish species should not be allowed until the potential threats of ecological disruption and disease spread have been fully researched.

6. Pollution

The Scottish shellfish farming industry is dependent on its quality image, associated with clean waters free from pollution and disease. Shellfish require neither artificial feeding nor chemical treatments, therefore their impacts are likely to be significantly less than those of finfish farming. However, these impacts have not been studied in the Scottish situation.

EC Directive 79/923/EEC on the quality required of shellfish waters is designed to protect and improve the quality of water used for the support of wild, harvestable molluscs. Its requirements apply only to waters designated by governments as shellfish waters. The UK Government has not designated waters around shellfish farms under this Directive.

Main Recommendations

- Impacts of shellfish farming on water quality and the seabed in Scottish sea lochs require further research.
- Large scale shellfish farming developments are inadvisable before the environmental impacts are properly understood.
- The UK Government should designate coastal areas around shellfish farms under the Shellfish Waters Directive 79/923/EEC.
- The parameters of the Shellfish Waters Directive should be widened to include chemicals and antibiotics used on finfish farms.

7. Predation and Predator Control

Concentrations of shellfish in cultivation attract natural predators. Good husbandry should eliminate the threat posed by crabs and starfish. Intertidal cultivation of shellfish can result in serious predation by shore birds. Eider duck predation on mussel farms can be an area of conflict. However, there are non-destructive methods to reduce the impact.

Main Recommendations

- Advice on predator control should be more readily available during the planning and establishment of shellfish farms.
- Predator control practices should be stipulated in the Crown Estate lease conditions.

Part I: The Industry

1.0 The Shellfish Farming Industry in Scotland

1.1 Introduction

Shellfish farming is well suited to the environmental and socio-economic conditions of the North and West of Scotland, and is highly compatible with the crofting lifestyle of much of the indigenous population. The sheltered coastal waters of Scotland are largely free from pollution and disease, and provide favourable conditions for shellfish cultivation. Shellfish farming is in general an environmentally benign enterprise requiring no inputs of enriching foods or polluting chemicals.

1.2 Estimated value

The aquaculture industry in Scotland was worth £112 million in 1990, with salmon taking the majority share of £104 million, trout £7 million, and the farmed shellfish sector (mussels, oysters and scallops) just £1 million. Shellfish therefore represent less than 1% of the industry total.

1.3 Planning and development control

The control of development is currently the responsibility of the landlord, the Crown Estate, which operates a consultation procedure on lease applications for shellfish farms as for salmon farms. A discussion of the shortcomings of this system and recommended reforms is contained in *Marine Fishfarming in Scotland* (SWCL, 1988) and its *Review* (1990). The Shetland Islands Council has issued Works Licences which under the Zetland County Council Act 1974 permits the establishment of finfish and shellfish farms.

Marine fishfarming in Scotland - Development Strategy and Area Guidelines was published by the Crown Estate in 1989. This document is a locational strategy indicating where the landlord believes there are constraints against the location of new fish farms, and exploring the scope for new sites. It does not satisfy the need for strategic national planning guidelines which would set out the Government's policy for integrating economic, social and environmental objectives. Such guidelines are in preparation by the Scottish Office (1992).

Highland Regional Council has prepared Framework Plans for most fishfarming areas within the region. These plans have no statutory authority. They are used by the council as a basis for its responses to consultation on sea bed leases by the Crown Estate.

In July 1988, the Government introduced the Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988, implementing the European Directive on Environmental Assessment (85/337/EC). This Directive should be extended to cover shellfish developments, which may increasingly become larger scale, or affect sensitive sites.

1.4 Development

The commercial uptake of shellfish farming has been slow compared to salmon farming, largely due to relatively low level profits (Gruer, 1987). As a result, there has been relatively little investment in developing technology and the burden has lain largely with small private concerns, with few resources to pit against production problems, or to see their businesses through financial difficulties. However, firms such as Scallop Kings plc and Kishorn Shellfish have recently invested heavily in shellfish cultivation.

Recent interests in shellfish farming has been reflected in the number of applications to the Crown Estate Commissioners (CEC) for shellfish farming leases. From the establishment of the formal consultation procedure (1 October 1986) until 30 September 1990, there have been 267 shellfish leases allocated in Scottish coastal waters. Add to this the number of farms previously established and the total exceeds 500.

The numbers of active and registered shellfish farms up to 31 December 1990, published by the Scottish Office Agriculture and Fisheries Department (SOAFD, 1991), from data collected by the Shellfish Farm registration scheme, are shown in Figure 1.

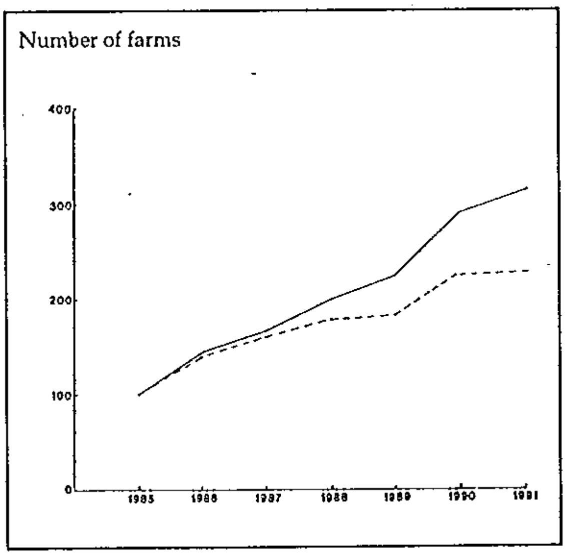


Figure 1.Growth of shellfish farming in Scotland (—— registered farms; - - - - active farms) (Data from SOAFD 1991 and Fish Cultivation Team, SOAFD *pers. comm.*)

A general levelling off in activity during 1988-89 was followed by an increase of about 30% in the number of registered farms in 1990. This increase is partly due to the issuing of new shellfish leases but also to a more comprehensive follow-up procedure introduced by SOAFD to ensure all shellfish farmers register with SOAFD. A number of enterprises stopped production in 1990, due to marketing problems and poor spat settlement in 1989, leaving 229 'active' shellfish farms in Scotland.

The regional distribution of licensed shellfish farms (although not necessarily active) is as follows:

Highland Region	238	(CEC, 1989b)
Argyll and Bute District	146	"
Western Isles	111	"
Orkney	27	"
Shetland	6	(SOAFD, 1991)

Figure 2 shows the locational distribution of shellfish farm sites in Scotland, excluding the small number in Shetland.

1.5 Production

Accurate statistics for production are not available and estimates vary considerably. Certain statistics on shellfish production have been kept since January 1986 by SOAFD, but not until 1988 (and continued in later years) was a determined effort made to compile a complete estimate of shellfish production (SOAFD, 1991) (Figs. 3a-d, Fig. 4). The Sea Fish Industry Authority (SFIA) produced figures for 1985 and 1987 and predicted trends for 1989 and 1992. These suggested that there would be a substantial growth of the industry (SFIA, 1988). Some new large-scale shellfish farms have since been established, but the shellfish farming industry continues to perform less well than predicted. One factor is almost certainly a degree of over-optimism in the predictions. Another is the structure of the industry itself. Most farms are relatively small-scale units and most of the production of mussels and oysters comes from a small number of producers (SOAFD, 1991).

1.6. Employment

SOAFD does not publish figures for employment in shellfish farming at present. Estimated employment is 108 full-time, 154 part-time and 60 casual workers (NCC, 1989). Many registered farms are small-scale 'family' concerns. The level of indirect employment created by the industry is to date small.

1.7. Financial assistance

Only in 1980 did the industry start to grow, with considerable financial assistance from the Highlands and Islands Development Board (HIDB). The Integrated Development Programme (IDP) stimulated mussel farming in the Western Isles (1982-7), and the Agricultural Development Programme (ADP), launched in 1988, is providing a similar impetus in the Inner Hebrides, Orkney and Shetland, offering up to 95% of fixed capital costs as grants.

The main costs of shellfish culture are the initial capital investment and labour costs. In general little working capital is required, (although those farming Pacific Oysters must purchase new stock each year) but the value of the product is low compared to finfish. Hence the industry responds well to high levels of grant aid during the start-up period, although a large initial grant can encourage over-optimism.

1.8. Future growth

At the end of 1988 it was anticipated that there would be an accelerated growth in shellfish farming as producer confidence grew, market demand improved, and salmon producers diversified their fish farming interests (Gruer, 1987). In spite of the general feeling of optimism, shellfish production actually declined in 1989, with only a limited recovery in 1990. Although shellfish cultivation is considered an activity within reach of a large number of local people and a prime sector for development, it requires the assurance that producers will not be left holding unsold stocks. Appropriate advisory and financial support are seen as essential (Sutherland, 1988).

2.0 Shellfish Farmed in Scotland

Falling into the informal classification 'shellfish' are species of Crustacea (crabs, lobsters, prawns (*Nephrops*))and Mollusca (mussels, oysters, scallops).

At present the freshwater Signal Crayfish is the only crustacean farmed in Scotland, although there is some interest in restocking natural lobster fishing grounds with hatchery-reared juveniles, provided legal problems over subsequent ownership can be resolved. The molluscs currently cultivated in Scotland are all bivalves. The species outlined below are already being farmed commercially, and other shellfish species are likely to be farmed in the foreseeable future.

2.1 Oysters

2.1.1 Species

The Native Oyster, *Ostrea edulis*, (Fig. 5a) was once abundant in Scotland and supported a large natural fishery. Since the early 1900s the oyster beds have declined due to successive poor spatfalls caused mainly by over- fishing and perhaps increasing pollution. Commercial cultivation of the Native Oyster in Scotland is minimal due to a lack of supply of spat (mobile larvae) from hatcheries. The recent introduction of the

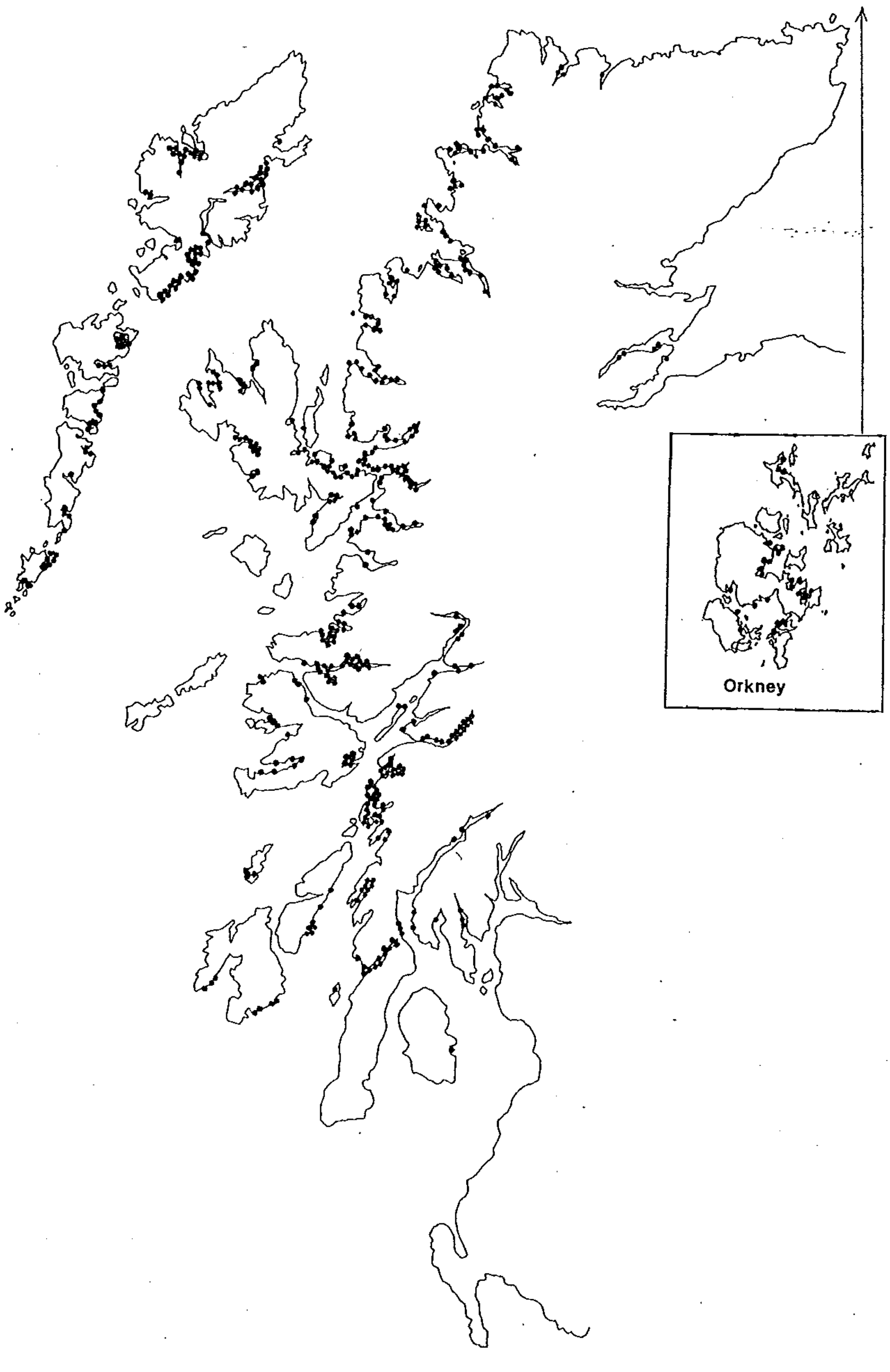


Figure 2. Shellfish farming leases in Scotland (data from CEC up to 31.3.89)

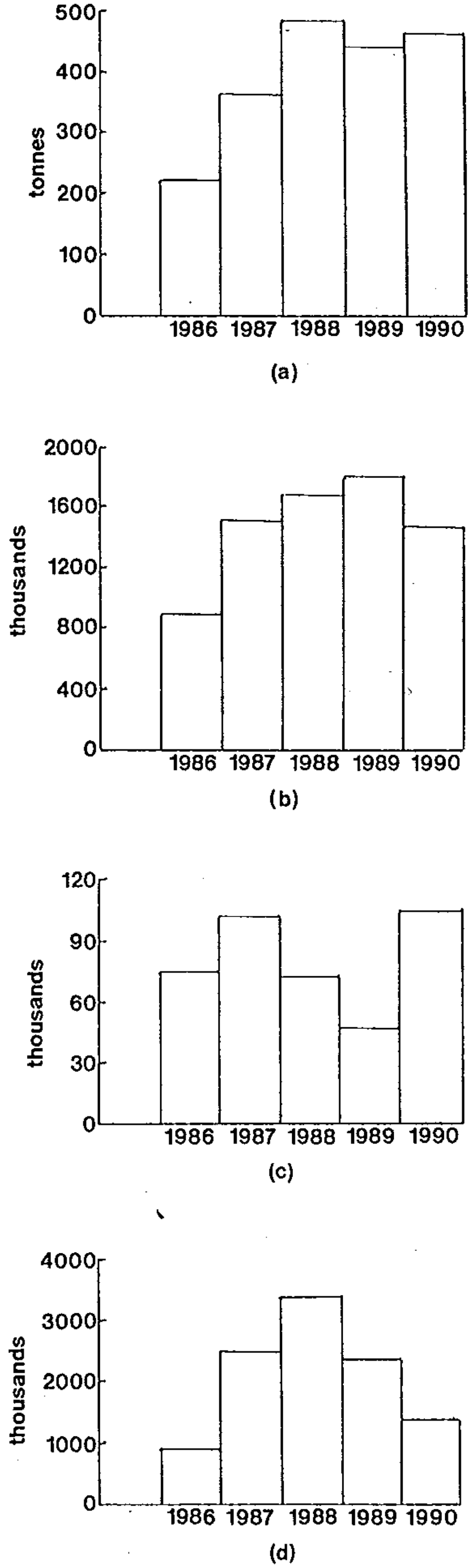


Figure 3. Shellfish production in Scotland (a) mussel, (b) oyster, (c) King Scallop, (d) Queen Scallop

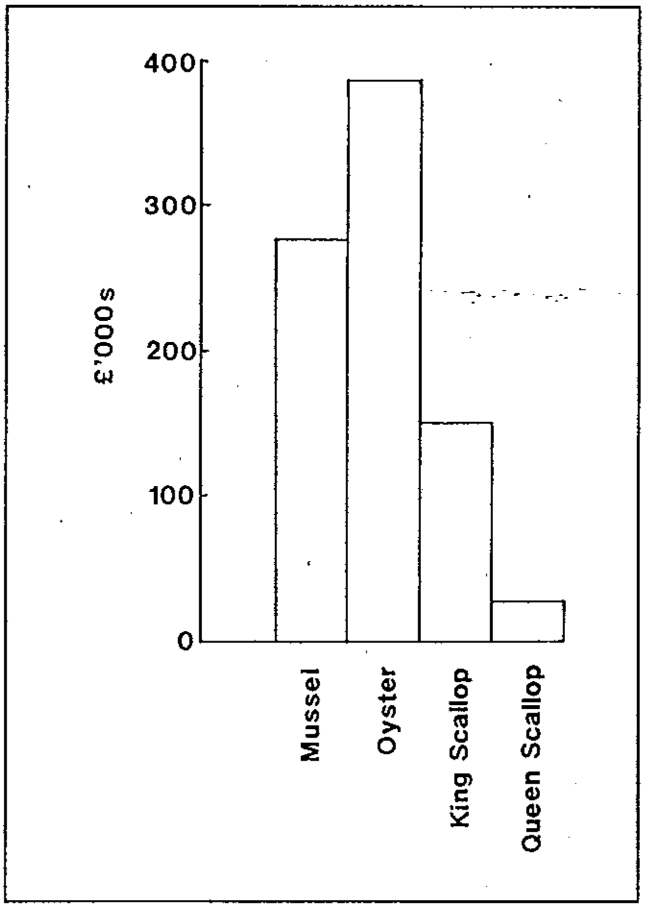


Figure 4. Estimated value at first sale, 1991.

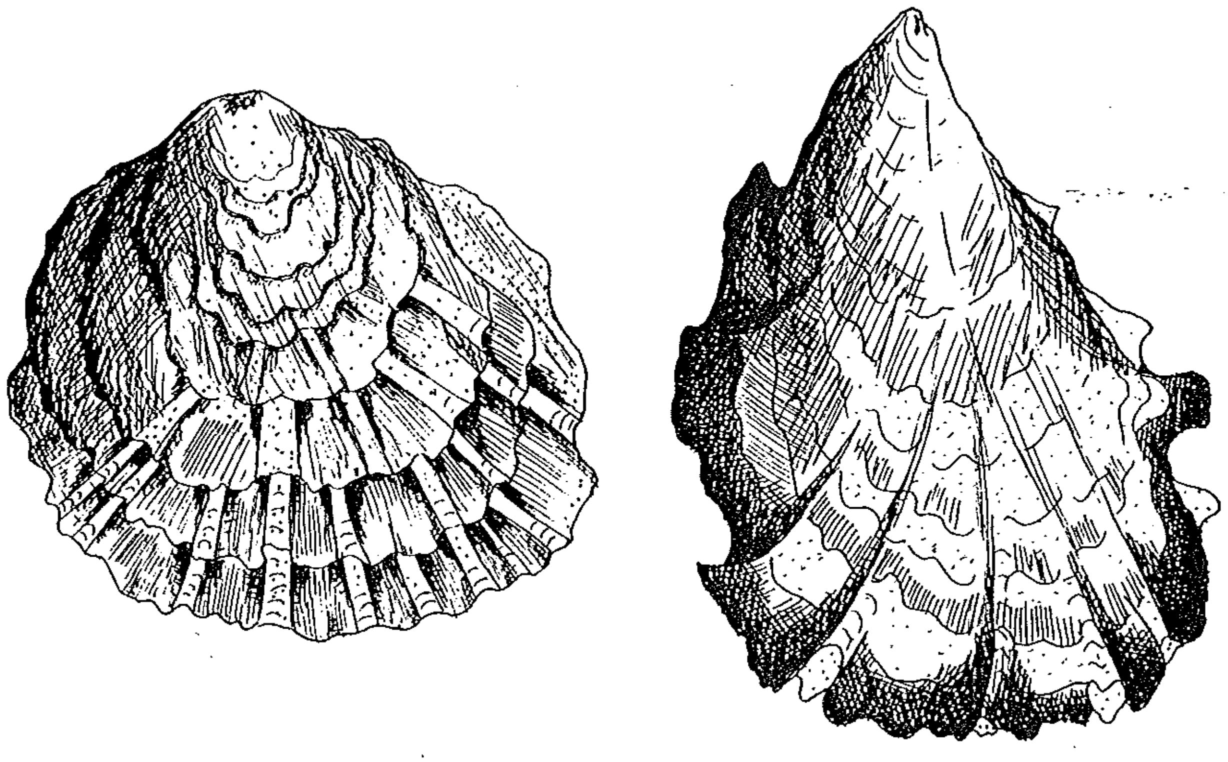
parasitic protozoan, *Bonamia ostrea*, to Britain from France, is a serious concern, and untreatable except by destroying stock and leaving the area fallow for 3-5 years. The disease occurs in the south of England, but at present is absent from Scotland (see 4.1).

The Pacific Oyster, *Crassostrea gigas* (Fig.5b) introduced originally to France and the US from the warm waters of the Pacific, has now achieved sizeable commercial production in Scotland. The main advantages of the Pacific Oyster over the Native Oyster are:

1. faster growth, *C. gigas* reaches market size in 2-4 years rather than 5+ years.
2. *C. gigas* does not spawn in UK waters, therefore no close season is required.
3. hatchery production of seed is more reliable, allowing continuity and quality of supply.
4. generally *C. gigas* is a more robust species, not susceptible to *Bonamia*.

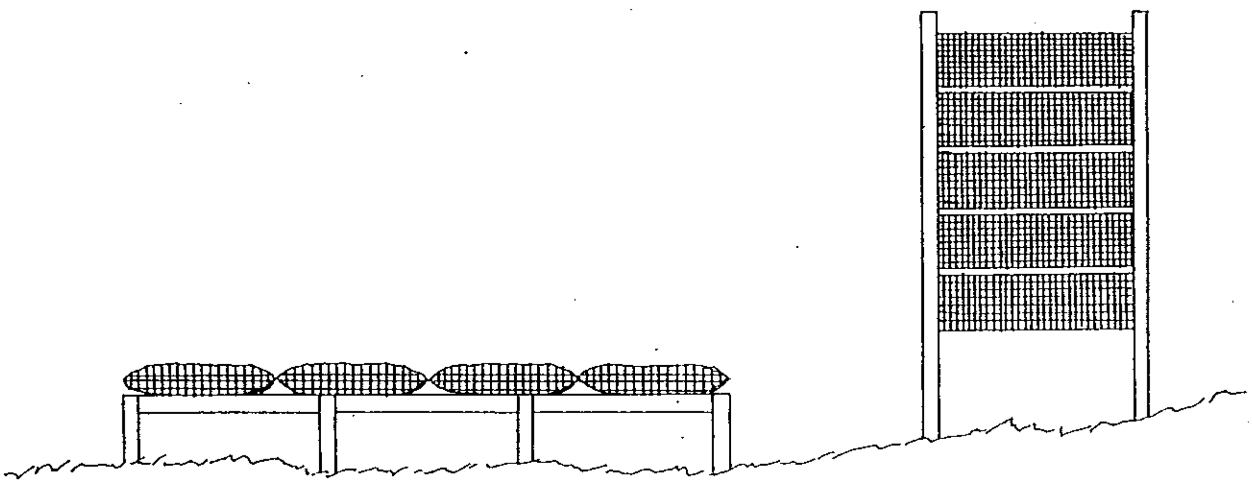
2.1.2. Cultivation

In commercial Pacific Oyster farming, the grower is dependent ultimately on a supply of oyster seed from a hatchery. Here, selected brood stock are conditioned in warmed water with enhanced algal feeding. Between hatchery and ongrower, seed may pass through 'nursery' operators who operate upwelling



(a) (b)

Figure 5. Oysters farmed in Scotland (a) Native Oyster (*Ostrea edulis*), (b) Pacific Oyster (*Crassostrea gigas*)



(a) (b)

Figure 6. Types of oyster cultivation (a) trestle with oyster bags, (b) stack of oyster trays.

containment systems. Ongrowers then buy in stock, the basic approach being one of containment, exclusion of predators and optimization of growth. A number of ongrowing techniques are currently practised in Scotland:

a) **intertidal** - oysters are grown in perforated trays or plastic mesh bags supported on trestles (Fig. 6a)
b) **subtidal** - stacks of trays containing the oysters are lowered onto the sea bed from a boat (Fig. 6b)
c) **hanging culture** - this relies on rafts or buoyed longlines, to support the oysters in trays or nets hanging in the water beneath (similar to those used for mussel cultivation (see 2.2.2)).

Stock from subtidal and hanging systems is continually immersed in sea water which enhances the growth rate. These subtidal oysters must be 'hardened off' intertidally for a few weeks prior to marketing. This serves to round-off the shell, and 'trains' the oysters to shut tightly which increases their shelf-life after harvesting.

2.2 Mussels

2.2.1 Species

The native **Common Mussel**, *Mytilis edulis* (Fig. 7), is the only species of mussel cultivated in Britain.

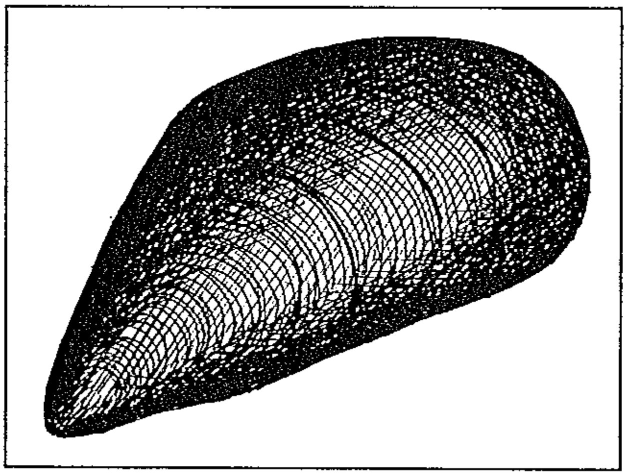


Figure 7. Common Mussel (*Mytilus edulis*).

2.2.2 Cultivation

There are three methods of mussel production.

a) **Dredged wild mussels** - mussels from the wild fishery (e.g. Dornoch Firth) are harvested rather than farmed.
b) **Cultivated bottom-grown mussels** - small mussels are harvested and relocated in controlled density, in areas which will allow accelerated growth. Problems can arise with control of stocks, rights to the sea bed, and access. An alternative cultivation method is to transfer near-market size stock from intertidal beds to mesh tubing (see below).
c) **Cultivated rope-grown mussels** - the essence of mussel 'farming' is to suspend ropes in the water column where the spat settle naturally and feed on microscopic plankton. Advantages of this form of cultivation are:
   - rapid growth;
   - excellent meat content;
   - freedom from grit;
   - thin, attractive shells;
   - reduced predation by bottom-dwelling crabs and starfish.

Cultivation of mussels depends upon sufficient collection of spat. This is done by suspending settlement ropes, a month before spatfall, to receive a coating of small algae and hydroids, which allow the naturally occurring planktonic mussel larvae to settle more easily. These ropes can have wood or plastic pegs inserted every 0.5m to increase the area available and prevent slipping when the mussels grow large. Alternatively, naturally settled spat can be collected and packed into plastic mesh tubing. The mussels migrate out through the mesh and attach to each other where they continue to grow. Cotton meshes with a synthetic core may also be used; the cotton eventually rots away, leaving the mussels attached to a central rope. The production period is approximately two years for a 50mm mussel.

Basic cultivation equipment consists of a floatation system either of rafts or longlines supporting a number of hanging, weighted ropes (Fig. 8). Both systems have their merits and drawbacks:

Raft
unsuitable in exposed areas
expensive initially
good platform to work on
easier to protect from eiders

Longline
usable in most conditions
inexpensive
large boat needed for servicing
difficult to protect
additional flotation needed
more obstruction to navigation
more uniform growth

Husbandry involves maintaining a suitable density by thinning stock on the ropes. Thinned mussels can be ongrown in netting tubes.

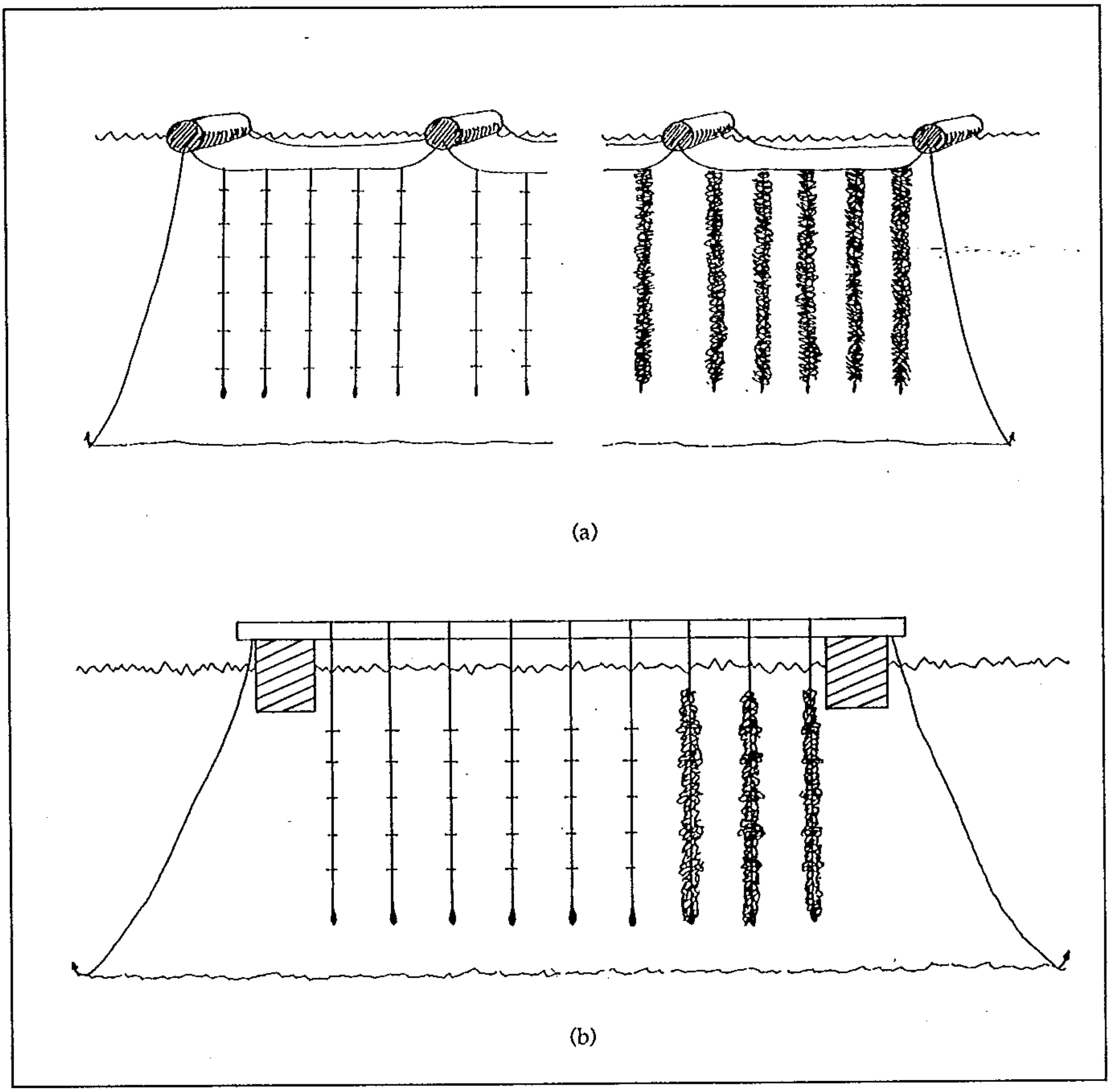


Figure 8. Types of mussel cultivation (a) longlines, (b) raft (adapted from Drinkwater, 1987)

2.3 Scallops

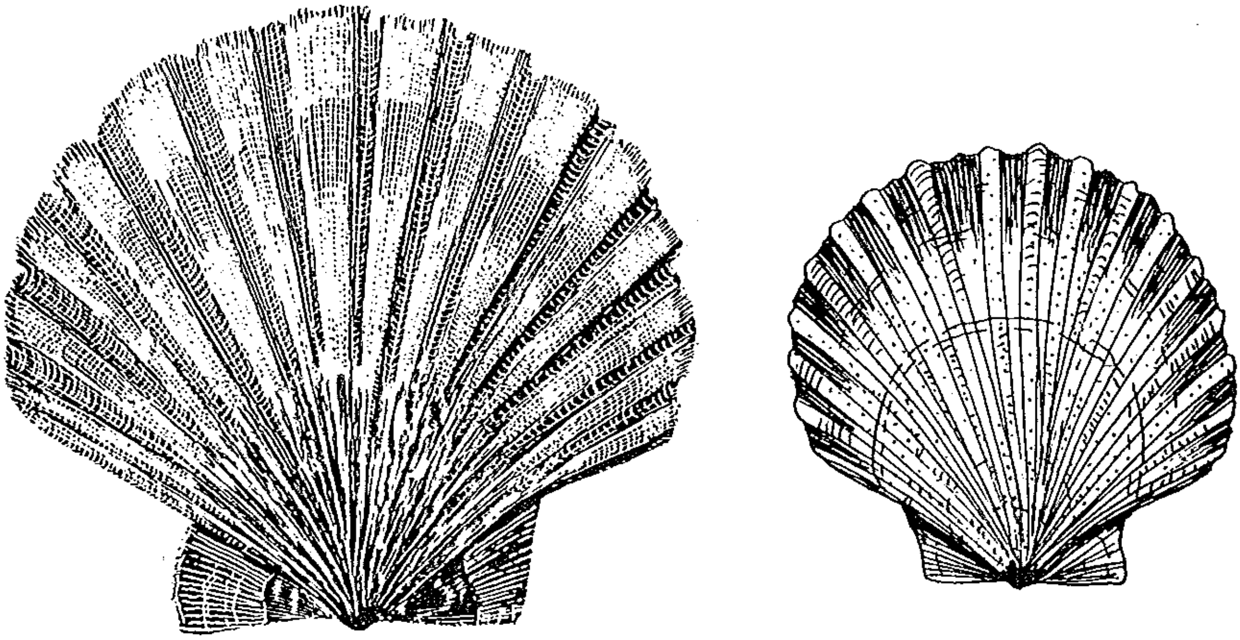
2.3.1 Species

Two commercial species of scallop are found around the coast of Scotland, the **King or Great Scallop**, *Pecten maximus*, normally known as 'Kings'; (Fig. 9a) and the **Queen Scallop**, *Chlamys* or *Aequipecten opercularis* (Fig. 9b), commonly known as 'queens' or 'queenies'. Small Queen Scallops are marketed under the name of 'Princess' scallops, the entire contents of the shell being eaten, unlike the King and Queen Scallops where only the adductor muscle and gonad are eaten. King Scallops are also called 'clams' throughout Scotland. 'Clams' in this report refer to the Manila Clam, *Tapes philippinarum* (see 2.4).

2.3.2 Cultivation

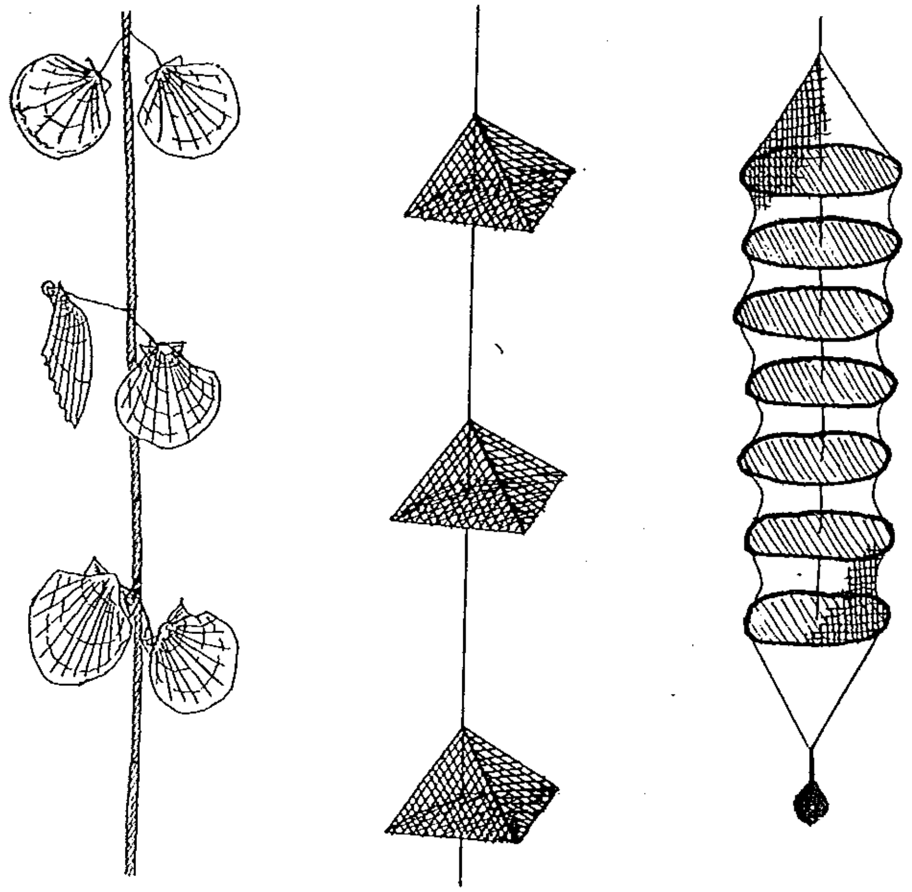
Scallop spat of both species occurs naturally around much of the Scottish coast. Cultivation of scallops is based on the collection of seed, which settles in monofilament mesh-filled bags, placed in the sea during early summer. The larvae settle in the bags where they grow until ready to detach, but being too large to get through the mesh, are trapped.

Collector bags are lifted in autumn. The species are sorted and then placed in small nets which are suspended from buoyed longlines. As they grow they are moved to larger mesh pearl or lantern nets (Fig. 10). The production period for the King Scallop is around 4 years to reach a minimum market size of 10cm.



(a) (b)

Figure 9. Scallops farmed in Scotland (a) King Scallop (*Pecten maximus*), (b) Queen Scallop (*Chlamys opercularis*).



(a) (b) (c)

Figure 10. Types of scallop cultivation (a) ear hanging, (b) pearl nets, (c) lantern net.

Chlamys can be marketed as a Princess Scallop after 12-18 months (4-5cm), or as a Queen Scallop after 24-36 months, at a size of approximately 7cm (SFIA, 1990). The major husbandry operations are the changing and cleaning of nets and sorting.

The high cost of culture nets has led to interest in an alternative culture system known as 'ear-hanging', which is less capital intensive. This involves drilling a hole through the lobe of the shell and threading a tag through it. This also allows enhanced growth and lower losses, due to the lack of restriction from netting around the stock.

Sea bed cultivation involves transferring 2 year old, net-grown Kings or Queens to an area previously cleared of substrate. Losses of up to 30% can be expected from predation and migration. Harvesting entails either dredging or diving, the latter having much less impact on the benthic flora and fauna.

2.4 Manila Clams

2.4.1 Species

The Manila Clam, *Tapes philippinarum* (Fig. 11) was introduced from Japan to France in 1973. This species is grown on a commercial scale at a few sites in the south of England as well as in European countries such as Ireland, France, Spain and Italy. Over the last few years SFIA has been carrying out production investigations at their research station at Ardtoe. Early results appear to have been encouraging, with a three year grow-out period. However, as yet there is only commercial production in Orkney.

2.4.2 Cultivation

Cultivation relies on hatchery-produced seed now available from two UK sources. The clams are then grown intertidally on sandy substrates, into which they bury themselves to a depth of 2.5-4.0cm. Culture plots (Fig. 12) are situated near the low water mark (LWM), and are rotovated and raked to remove predators such as the shore crab. Then the seed is sown and protected from predators, by plastic net covering which is buried on either side of the plot.

Another method using gravel trays is being assessed by SFIA. These would be mounted on trestles below low water. Initial findings suggest that this method allows better growth, higher survival and 100% recovery of clams, although frost damage could be a problem (SFIA, 1989).

Husbandry requirements are minimal involving basic net cleaning to remove algae and removal of predators. The clams are harvested by digging or suction dredging. These processes are suitable for mechanisation on a large scale, using tractors and modified potato harvesters.

Securing the right to harvest cultivated stocks requires a Several Order (see 8.0).

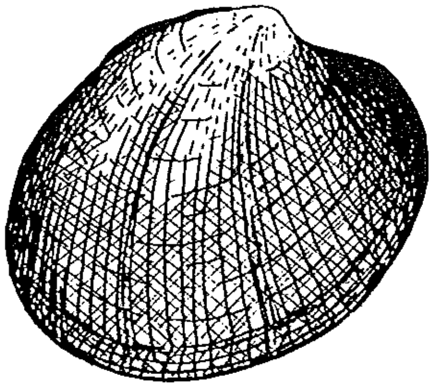


Figure 11. Manila Clam (*Tapes philippinarum*)

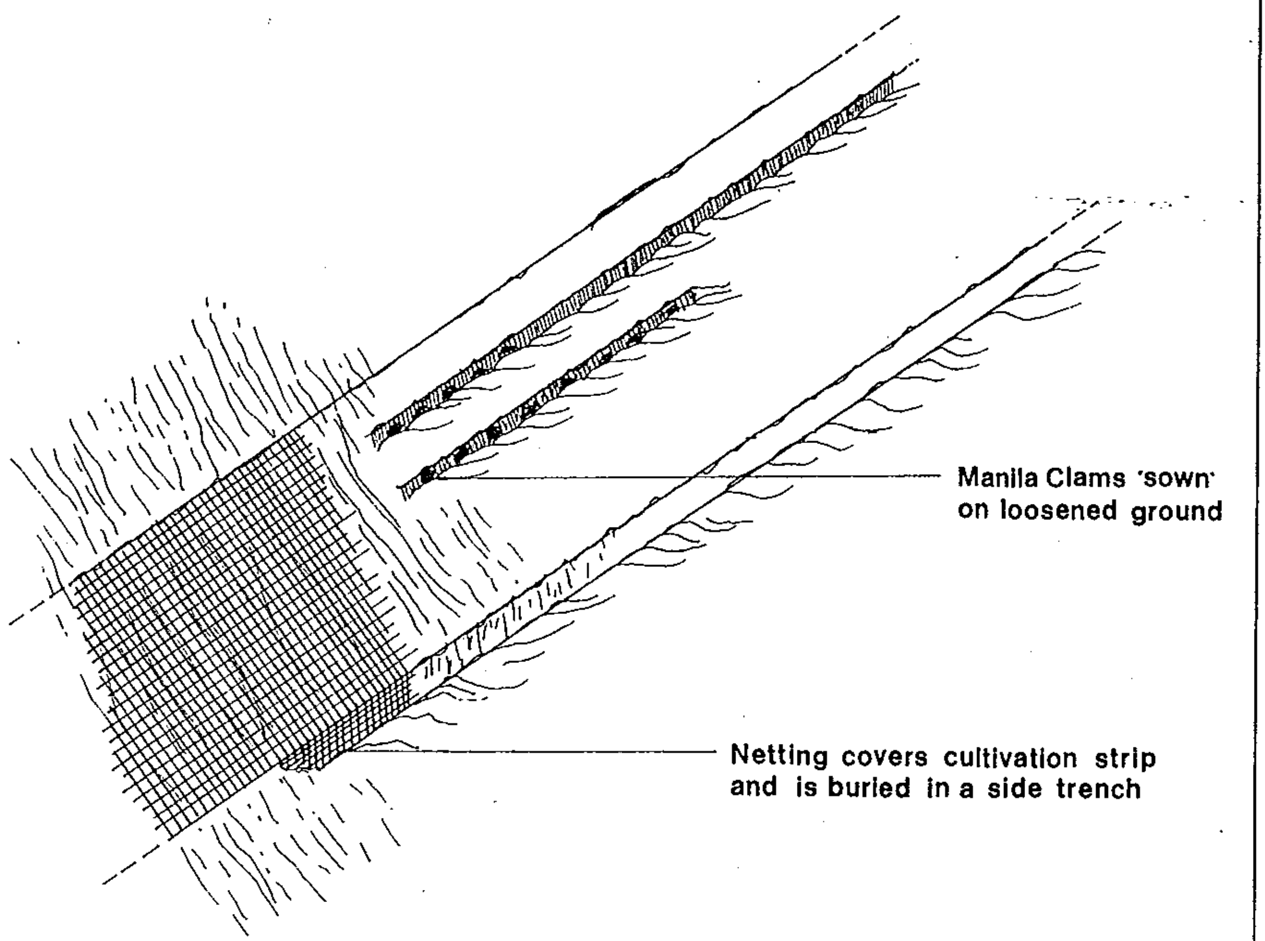


Figure 12. Manilla Clam cultivation strip

2.5 Lobsters

2.5.1 Species

The native European Lobster, *Homarus gammarus*, occurs on rocky substrates around most of the Scottish coast, being fished using the traditional method of baited traps or creels. There is also a small by-catch from trawl fisheries.

2.5.2 Cultivation

Depletion of the wild stocks by overfishing and the consistently high value of the lobster, has stimulated interest in artificial rearing. In the mid-1970s Ministry of Agriculture, Fisheries and Food (MAFF) scientists developed a system for hatching larvae from egg-bearing females captured from the wild. It takes 5-6 years for the lobster to reach marketable size at ambient UK water temperatures. This may be reduced by artificially raising the temperature.

A major problem is the requirement of keeping the stock in individual containers for almost all of the growth cycle due to their cannibalistic nature. Expensive husbandry and maintenance (including feeding costs) are the principal reasons for the lack of commercial uptake to date.

An alternative approach being carried out by MAFF and SFIA is to restock natural fishing grounds with hatchery-reared lobsters (SFIA, 1989).

Rights of access to this fishery again raise legal problems

Part II: The Impacts

3.0 Landscape Effects

3.1 Buoys and lines

In sea lochs both mussel and scallop farms are generally visible as long rows of buoys. Often an unnecessary number of surface buoys are used on scallop longlines in an attempt to reduce the amount of maintenance required for buoyancy adjustment. Some farms rely almost entirely on sub- surface buoyancy, with a few surface buoys as indicators. Field surveys by Cobham Resource Consultants (CRC) have revealed that there is a fairly wide spectrum of sizes and colours used, with a predominance of orange and pink. The least conspicuous are black or green, whereas rows of buoys with assorted colours and sizes are the most conspicuous (CRC, 1987).

Brightly coloured marker buoys are essential to ensure safe navigation in the farm vicinity, under the Coast Protection Act 1949. However, CRC suggested that a high proportion, for example three buoys out of four, could be a dark, neutral colour, thus reducing the overall visual impact. This advice has resulted in a number of manufacturers incorporating grey buoys in their range of products. New shellfish farmers are using these neutral colours as a result of their wider availability, but established farmers often cannot afford the extra cost of new buoys. Washed-up buoys can become a litter problem, and the monofilament net bags are a hazard to wildlife.

Recommendations

- *Sub-surface buoyancy should be used wherever possible.*
- *Monitoring procedures should be improved in order to enforce the conditions relating to design, imposed by sea bed lease agreements.*
- *Washed-up buoys and net bags should be retrieved routinely from the shore.*

3.2 Rafts

Wooden framed oyster and mussel rafts have a lower profile than fish cages, having no protruding hand-rails or feed sheds. Excessive flotation is usual initially when the shellfish are small, to avoid sinking as the animals grow. Buoyancy is provided by substantial blocks of polystyrene, flotation tanks or buoys. Fragmentation of polystyrene can lead to major litter problems. Variable buoyancy submersible rafts are being tested by SFIA but are not yet in commercial production.

Recommendation

- *The use of unprotected polystyrene should be discouraged. If used it should be contained in plastic flotation buoys.*

3.3 Trestles

This system has negligible scenic impact, the net bags and trestles only being visible at very low tides, perhaps a few times a month. When they are exposed they are barely visible on the foreshore due to seaweed growth and their low profile.

3.4 Sea bed cultivation

This technique involves growing Manila clams and scallops in protected culture plots, on sandy substrates or mixed sand and mud. Clams are grown intertidally whilst scallops are grown in the subtidal zone. These substrates are not widely available intertidally on the West coast, but the large East coast estuaries, despite lower temperatures, may be very suitable for this form of shellfish cultivation. However, there could be serious implications for bird populations (see 7.2). The extent of this problem may be very much greater in southern UK where conditions favour more widespread shellfish cultivation.

Intertidal cultivation involves either the erection of fences, or covering areas of the foreshore with plastic netting to exclude predators. The netting becomes covered by weed to a certain extent, and is only exposed at low tides, but these structures could have a significant scenic impact.

Methods proposed for harvesting Manila clams include suction dredging, and the use of converted potato harvesters. These may lead to habitat destruction, and depending on scale, could have a considerable environmental impact.

Recommendation

- *Before intertidal cultivation of shellfish begins to operate on a commercial scale, guidelines on scale, siting, and design should be established for the intertidal zone.*

3.5 Onshore developments

These are generally small-scale and make use of existing buildings and piers. Design and location are under the control of local planning authorities.

4.0 Pathogens, Pests and Diseases

4.1 Molluscan pests and diseases

Most areas in Scotland are free from pests and diseases affecting molluscs. Only a few areas in the Firth of Clyde, Firth of Forth and Loch Sween are affected by the parasitic copepod *Mytilicola intestinalis* (Drinkwater, 1987). *Mytilicola* predominantly affects mussels, causing reduced growth, loss of condition and in severe cases, death.

The American Tingle *(Urosalpinx cinerea)* and the American Slipper Limpet *(Crepidula fornicata)* are also serious pests, although only occurring in south-east England at present (ICES, 1982 cited in NCC, 1989).

Bonamiasis is a disease of flat oysters (*Ostrea* sp.) which has spread from Brittany, France in 1979, to most European countries with significant oyster cultivation, causing losses of up to 80%. Since 1982, bonamiasis has been confirmed in coastal areas in southern and eastern England (Hudson & Hill, 1991), and outbreaks have been diagnosed in Ireland since 1987 (McArdle *et al.*, 1991). The causative organism is *Bonamia ostreae*, but the life cycle of the parasite is unknown.

With increased transfer of stock, and the possible extension of their biogeographical range northwards these parasites may be a future threat to the Scottish shellfish industry.

4.2 Legislation

Controls under the Sea Fisheries (Shellfish) Act 1967 as amended by the Diseases of Fish Act 1983, were designed to prevent the introduction and spread of serious pests and diseases of shellfish which may affect farmed and wild stocks.

Under the Diseases of Fish Act, the Registration of Fish Farming and Shellfish Farming Businesses Order (1985) requires the Fisheries Department to register all fish farming activities and, by centralising such details, secures better control of diseases among shellfish arising from the movement of stocks.

All deposits in coastal waters of molluscan shellfish, whether of home origin or imported, have to be licensed by the Marine Laboratory of SOAFD in Aberdeen, in accordance with orders made under the 1967 Act.

In January 1991, EC Directive 91/67/EEC concerning the animal health conditions governing the placing on the market of aquaculture animals and products was passed. The Directive comes into force in January 1993, and will control the movement of live shellfish, by a system of 'approved' and 'non-approved' zones and farms. These are divided into 'continental' and 'coastal' zones for fish, and 'coastal' zones for molluscs.

'Approved' and 'non-approved' zones and farms in Scotland have yet to be determined.

A 'coastal' zone consists of a part of the coast or sea water or estuary with a precise geographical delimitation which consists of a homogeneous hydrological system. In order to obtain 'approved' status, a zone must meet the requirements laid down to ensure that it is free from specified diseases. An 'approved' farm can exist in a 'non-approved' zone, but it must be supplied with water by means of a system which allows the destruction of the agents of disease.

The Directive relates to four diseases to which molluscs are susceptible: *Bonamia ostreae*, *Marteilia* sp., *Haplosporidium* sp. (all affecting *O. edulis*) and *Perkinsus* sp., which affects *Ruditapes decussatus* (native clam or palourde). It also covers aphanomycosis *Astacus* sp. (crayfish plague).

The Directive does not relate to shellfish species other than the native oyster and Manila clam, and only relates to disease, not pests of shellfish. This is particularly important since in Scotland most areas are free from pests widespread elsewhere in Europe.

Recommendation

- *It is imperative that disease transfer, both into Scotland and within Scotland, is prevented by comprehensive enforcement of this Directive by SOAFD and informed management practices.*

4.3 Human virus and bacteria transfer

Filter-feeding bivalves accumulate viruses and bacteria in their tissues at much higher concentrations than the surrounding water (Meyers, 1984 cited in NCC, 1989). This is a major area of concern, especially in areas where there are sewage outfalls containing human pathogens. Discharge of raw sewage into the marine environment is commonplace in remote Highland areas, although on a small scale, therefore careful site selection is essential to reduce the public health risk.

As part of its programme for the realisation of the free internal market for trade in live animals and animal products, the EC Commission is currently drafting specific measures on the Public Health conditions for the production and placing on the market of live bivalve molluscs (EC Draft Directive COM (89) 648). The Directive will come into force in January 1993, with some exceptions for structural facilities and upgrading of premises which may be implemented by 1995.

Uniform requirements for the treatment of bivalves will apply throughout the Community linked to the classification of the purity of the originating waters. Shellfish from the cleanest category will go straight for human consumption, whilst those from other categories will require some form of purification before market. There will be a ceiling category where no collection for human consumption will be permitted.

The draft proposals state that 'expedition centres' must be nominated where purification (if necessary), packing and registration will be carried out. This system is to enable products to be traced to their origin in the event of a public health problem. The Directive will probably be implemented under the Food Safety Act.

An upper limit has been laid down for the presence of Paralytic Shellfish Poison (PSP) content in edible parts of the mollusc, and the presence of Diarrhetic Shellfish Poison (DSP) in these parts must not be discernible (see 6.5). Molluscs must also be free from *Salmonella* and contain less than the upper limit of faecal coliforms.

Imports from third world countries will need to reach the standards equivalent to those of community products.

The Association of Scottish Shellfish Growers (ASSG) has advised its members to start bacteriological testing of their shellfish on a regular basis, if they have not already done so. This will allow them to assess the quality of the water, and to determine whether or not purification will be necessary. Purification involves placing the shellfish in tanks and allowing the animals to filter in sterilised seawater.

4.4 Finfish pathogens

Shellfish grown in close proximity to finfish farms may be able to accumulate virulent viral finfish pathogens acting as a reservoir for the disease (Meyers, 1984 cited in NCC, 1989). Many fish viruses have been found to be present in shellfish and still virulent after as much as 60 days in clean water (Meyers, 1984 cited in NCC, 1989). There is also the possible risk of disease transfer when the shellfish are moved (eg. from Dornoch Firth to Little Loch Broom). In an area such as Loch Sunart where there is a high density of both shellfish and finfish farms, this should be of concern to salmon farmers. Spacing guidelines, as listed in CEC (1989a), recommend a two mile distance between a shellfish and a salmon farm.

Recommendation

- *Further research is required into the capacity of shellfish to act as reservoirs for finfish pathogens. In the meantime precautionary separation from finfish farms should be maintained, and monitoring programmes established, to ascertain whether the spacing guidelines are adequate.*

5.0 Introduction of Non-Native Species

5.1 Shellfish introduced to Great Britain

Several species of shellfish have been introduced into Great Britain for cultivation. Production of the Pacific Oyster (*C. gigas*), probably the best known introduction, has now overtaken production of the native European Oyster (*O. edulis*). The Portuguese Oyster (*C. angulata*) has also been introduced into the UK.

Production, gametogenesis and recruitment investigations on the Manila Clam (*T. philippinarum*) suggest it will be the next major introduction to Scottish waters. Other species undergoing cultivation trials include the New Zealand Oyster (*O. lutaria*), the American Oyster (*C. virginica*) and the American Hardshell Clam (*Mercenaria mercenaria*).

5.2 Control of introductions

The introduction of non-native shellfish species into Scottish waters could result in ecological disruption, spread disease and other problems outlined below.

The release of non-native species of shellfish into the wild requires a licence from SOAFD (see 4.0). The Nature Conservancy Council for Scotland (NCCS) also has powers under the Wildlife and Countryside Act 1981 to control introductions and is consulted by SOAFD before a licence is granted. Section 14 of the 1981 Act makes it an offence to release or allow the escape into the wild of animals of a kind not normally resident in Great Britain in a wild state. The implications of this in relation to aquaculture, where species are not technically released, but are held in some sort of container, remain to be tested. Successful reproduction of contained adults to release free-living offspring would presumably be interpreted as a 'release'.

Recommendation

- *The definition of 'introductions', as applied in the Wildlife and Countryside Act 1981, needs to be reviewed and clarified. Licensing should be adapted in the light of this definition.*

5.3 Reproduction

The Manila Clam is not thought to spawn in Scotland due to the low water temperatures. However, Manila Clams are self-sustaining along the outer coast of Vancouver Island, where monthly mean summer water temperatures range from 13°C to 16°C (Hollister and Sandes, 1972).

In the long term, it is possible that Manila Clam spawning, leading to the production of a self-sustainable population, may occur due to :

1. acclimatisation;
2. elevated temperatures in sea lochs;
3. movements in water current and isotherm patterns.

In 1986 NCC and MAFF monitored a site on the Helford Estuary in Cornwall where spawning of Manila Clams was observed but the progeny were thought not to be viable because it was late in the season. In Scotland, the NCCS is believed not to be opposed to the experimental culture of Manila Clams, where mature conservation interest is not jeopardised, provided samples are examined for gametogenesis and spawning.

At Conwy, MAFF is carrying out work on the production of triploid shellfish, which would be safer for release into the environment (NCC, 1989).

5.4 Disease

All deposits in coastal waters of non-native molluscan shellfish are licensed by SOAFD to prevent the introduction and spread of serious pests and diseases (see 4.2). However, the effect of introductions can be subtle. It has been suggested that when an alien species or strain is introduced, unlike the native species it does not have the appropriate immunological defences, and therefore becomes susceptible to native disease pathogens. This allows the disease organism to become much more prevalent in the environment, and more virulent strains to be selected, such that it may eventually infect the native species (Mills, 1982 cited in NCC, 1989).

Recommendation

- *Appropriate licensing should be strictly imposed by SOAFD to control the spread of introduced species and any associated diseases (see 4.2).*

5.5 Disruption of the native community

Introduced species, both larval and adult stages, occupy similar niches in the marine environment to native species, presenting a threat to the balance of existing sea loch communities. This could be a major problem with commercial scale operations, which may not be detected during pilot studies.

To date, the Pacific Oyster has not adversely affected the indigenous fauna; this may be due primarily to its contained status. However, since its introduction to south-west France in the early 1970s, it has completely replaced *C. angulata* in French waters south of Brittany, breeding further north in the Netherlands in warm summers. Concern has been expressed about the likelihood of escapes from intertidal Manila Clam culture plots where only a top containment net is used. Those which do escape may be eaten by crabs or shore birds (intertidal shellfish cultivation may have serious implications for shore birds - see 7.2).

SFIA has observed settlement of *T. decussatus* in Manila Clam plots at Ardtoe. The plots act as a 'refuge' and offer protection from predators.

The Irish Government has recently allowed the introduction of *Platinopecten japonica* (Japanese Scallop) to its waters in order to establish it as a self-sustaining stock. The native scallop has been depleted by overfishing, and since *P. japonica* is thought to be faster growing, it was decided to effect a substitution. There appears to be a virtually unanimous view in the UK that this was not the right approach. If any of the problems noted above are brought in by *P. japonica* then it seems inevitable that they will cross the Irish Sea to Britain (P H MacMullen, 1991).

Recommendation

- Commercial scale farming of introduced species should not be allowed until the potential threats of ecological disruption and disease spread have been fully researched in Scotland

6.0 Pollution

(Reference is made to *Fishfarming and the Safeguard of the Natural Marine Environment of Scotland* (NCC, 1989) from which sections 6.1 and 6.2 are compiled.)

6.1 Effects on the water column

6.1.1 Oxygen depletion

The dissolved oxygen requirements of shellfish are generally less than those of finfish. There is no data relating to the Biological Oxygen Demand (BOD) of shellfish wastes.

6.1.2 Depletion of essential nutrients

Shellfish farming unlike finfish farming does not involve inputs of nutrients to the water column, because shellfish feed only on the naturally occurring plankton in the water. Indeed the high filtering rates of shellfish may result in the depletion of essential nutrients (nitrogen, phosphorus and carbon) from coastal waters.

6.1.3 Modification of the nutrient cycle

Changes in water quality have been detected as water passes through a shellfish farm with both ammoniacal nitrogen and inorganic phosphorus increasing.

6.1.4 Effect on the algal community

Shellfish farming may stimulate primary productivity due to the rapid recycling of nutrients. However, this stimulation of primary productivity must be more than balanced by the fact that shellfish are net removers of nutrients (and algae).

6.1.5 Effect on the zooplankton community

Production of large numbers of shellfish larvae could influence the zooplankton population structures due to increased competition for resources. Zooplankton may also be filtered and voided as pseudofaeces by the filter feeders. Although no data is available for Scotland, high densities of shellfish farming may cause disturbance to the indigenous zooplankton communities in enclosed locations, with ecological consequences as yet unknown.

6.2 Effects on sediments and benthos

6.2.1 Build-up of organic sediments

Bivalve molluscs are filter-feeders, feeding mainly on phytoplankton, which they filter out of the water. They operate a primary sorting mechanism to reject unacceptable material in the form of 'pseudofaeces'. The undigested portion of food is then also expelled as faecal waste. A study in Sweden revealed that within 6-15 months of the establishment of a mussel farm, bivalves, sea urchins and brittle stars were replaced by opportunistic polychaetes, organisms indicating organic enrichment (Mattsson & Linden, 1983 cited in NCC, 1989). This compares with three months at finfish farm sites. There was only minor recovery 12 months after the cessation of operations.

The impact of shellfish farms on the sea bed environment is unresearched in Scotland, but it will relate in severity to farm size, husbandry, water movements, depth, primary productivity and season.

6.2.2 Physical modification of sediments

Production equipment can induce sedimentary changes (and subsequent sediment community changes) by accumulation or erosion, especially in the intertidal situation. The physical structure of the sediments is also modified by the deposition of shells.

6.2.3 Physico-chemical nature of the sediments

Solid waste products differ from the natural sediments in terms of nutrient content. They are associated with increased oxygen demands, decreased redox potential, raised pore water ammonium concentration, and hydrogen sulphide production.

Recommendations

- *Impacts of shellfish farming on water quality and the sea bed requires research.*
- *Large scale shellfish farming developments are inadvisable before the environmental impacts are properly understood.*
- *Care should be taken to avoid siting shellfish farms over sea bed communities of known interest and value.*

6.3 Chemical pollution affecting shellfish

6.3.1 Antifoulants

Organo-tin compounds such as Tri-butyl Tin (TBT), formerly used by yachtsmen and fish farmers to prevent the growth of seaweeds and other organisms on hulls and nets, have serious effects on both cultivated and wild species of shellfish. For instance, TBT distorts the growth of the Pacific Oyster *(C. gigas)* and causes imposex in dogwhelks. TBT products were banned from use on fish farms and small boats in 1987, but are still used on vessels over 25m.

6.3.2 Aquagard

This chemical, formerly called Nuvan 500 EC, is an organophosphate pesticide (active ingredient dichlorvos) used to treat sea lice infestations on farmed salmon. Dichlorvos is particularly toxic to the larval stages of arthropods such as lobsters and crabs. There is concern that the widespread use of Aquagard may affect the recruitment of both wild and commercial species of shellfish. This has led to calls from both shellfish farmers and environmentalists for greater caution, and preferably replacement by alternative treatment methods.

Recommendation

- *There is a need for more research into the potential impacts which chemicals used in finfish farming may have on farmed and wild shellfish. Existing SOAFD and Scottish Salmon Growers' Association research data should be made more readily available.*

6.4 Shellfish and salmon farm interactions

It has been suggested that shellfish may reduce eutrophication around finfish sites, through uptake of some of the enhanced primary productivity caused by nutrients released from fish farms (Wallace, 1980). However, shellfish (both wild and cultivated) may be adversely affected by chemical treatments used at salmon farms, and algal blooms associated with nutrient enrichment, and may contribute to organic deposition.

Recommendation

- *Research into the potential interaction between shellfish and finfish farming is urgently needed.*

6.5 Water quality affecting shellfish

EC Directive (79/923/EEC) on the quality required of shellfish waters is intended to safeguard the health of certain wild shellfish populations from various harmful consequences resulting from the discharge of pollutant substances into the sea.

In the UK, the Control of Pollution Act 1974 is used to implement the Directive, and in Scotland the River Purification Boards are the competent authorities to monitor water quality.

Article 1 of the Directive states "This Directive concerns the quality of shellfish waters and applies to those coastal and brackish waters designated by the member state as needing protection or improvement in order to support shellfish (bivalves and gastropod molluscs) life and growth and thus to contribute to the high quality of shellfish products directly edible by man".

The member states had to designate waters to which the Directive would apply by 1981, and set limit values corresponding to parameters including pH, temperature, colouration, suspended solids, salinity, dissolved oxygen, petroleum hydrocarbons, organohalogenated substances, certain metals, faecal coliforms, saxitoxin, and substances affecting the taste of shellfish (listed in an Annex to the Directive). The waters so designated had to conform to these values within six years of designation. The Annex also stipulates the frequency of sampling operations to be carried out.

The UK Government has to date designated 29 areas where wild shellfish are harvested from the sea bed. Of these, 11 are in Scotland, (Lochs Long, Goil, Fyne and Ryan, Kyles of Bute, Ayrshire coast, Dornoch Firth, Arbroath coast, St Andrews-Fife Ness coast, Fife Ness-Elie coast, and North Berwick-Dunbar coast).

In general, the waters of the North and West coasts of Scotland receive only minor inputs of domestic and industrial pollutants. However, chemicals and antibiotics used on finfish farms which are often in close proximity to shellfish farms may affect the high quality of the water and its shellfish product.

Article 9 of the Directive permits the Member States to lay down provisions relating to parameters in addition to those provided for in the Directive. Thus, chemicals and antibiotics used on finfish farms could be made parameters under the Directive, by amendment to the Control of Pollution Act 1974.

Recent algal blooms, with their threat of poisoning (PSP and DSP) have emphasised the need for water quality control around British shores. PSP and DSP are caused by molluscs which have ingested toxic-producing phytoplankton and dinoflagellates, such as *Gonyaulax* and *Dinophysis*. Not all algal blooms are 'man-influenced'. Algal blooms can be natural phenomena contributing to the marine ecosystem and are often difficult to distinguish from 'man-made' effects (Richardson, 1989).

Recommendations

- *The UK Government should designate more areas of coastline under the Shellfish Waters Directive (79/923/EEC):*
  a) in areas where shellfish farms are in close proximity to finfish farms;
  b) in areas where there are significant domestic or industrial discharges.
- *The parameters monitored by River Purification Boards should be extended to include chemicals and antibiotics used on finfish farms*

7.0 Predation and the Impact on Bird Populations

7.1 Predation and predator control

Eider ducks are the main predators of cultivated mussels on the West coast, and can cause losses as high as 2.7 kg of mussels per bird per day. The interaction has been comprehensively studied by Milne and Galbraith (1986).

The recommendations from Milne and Galbraith's study are being used as the basis for predator control guidelines *Mussel farms; their management alongside eider ducks* (NCCS, 1992), in which the following protection techniques are described.

(1) deterrence: shooting blanks in the vicinity of the flock, chasing the flock by boat and the installation of flapping plastic strips around the raft are most effective.

(2) exclusion: physical barriers such as brightly coloured, vertical netting or plastic skirts cut into strips, positioned underwater around the lines are only effective when used in conjunction with scaring. Raft-based farms and clumped longline farms are more cost- effective to protect than dispersed longline farms.

(3) modification of farming methods: providing alternative sacrificial food supplies.

The guidelines stress that culling is not a viable protective technique, but that it cannot be ruled out as an option of last resort at some periods of the year. A special licence obtained in advance from SOAFD is necessary, after justification has been provided for the cull.

These protective methods are relevant to shellfish farms which use hanging cultivation techniques.

Predation by shore crabs (*Carcinus maenas*) and starfish (*Asterias rubens*) is a potential problem to shore and bottom-grown shellfish. However, the impact can be reduced substantially by good husbandry, e.g. the use of plastic netting or crab-proof fences, and regular monitoring of stock.

Recommendations

- *Advice on predator control should be more readily available during establishment of the farm.*
- *Recommended predator control practices should be stipulated in the sea bed lease conditions.*

7.2 Impact on bird populations

Sea lochs on the West coast generally do not support large populations of potentially predatory birds such as sea duck, although they may have important local concentrations.

The situation is different on the East coast. The Moray Firth, where shellfish farming interests are on the increase, supports populations of sea duck of international importance, including the Common and Velvet Scoters, Long-tailed Duck and Eider (Crooke, RSPB, *pers. comm.*). Serious conflict between shellfish developments and sea duck populations could result.

Proposed mussel cultivation on Culbin Sands, Morayshire (an RSPB reserve and SSSI) raised considerable concern over the disturbance to wildfowl, and the conflict with waders such as oystercatchers. The proposal was withdrawn.

Pilot projects for Manila Clam cultivation in the Dornoch Firth, Islay and Orkney are currently underway. Unfortunately, cultivation on a pilot scale may under-represent the problems of full-scale commercial production, for the following reasons:

- the small scale may enable both native bivalves, and foraging birds to adjust and relocate. This would not be possible if the operation was spread over large areas of the intertidal zone, causing a considerable loss of wading bird habitat.
- maintenance and harvesting is infrequent, and done by hand. On a commercial scale it would be more frequent, mechanised and therefore both more disturbing and damaging.

Reports from Manila Clam farmers in Ireland suggest that oystercatchers have become a significant predator.

Recommendation

- *Although shellfish farming is not at present covered by the EC Directive on Environmental Assessment (85/337/EEC), a full assessment of environmental impact should be carried out and considered before shellfish developments on coastal SSSIs and SPAs (designated under the EC Birds Directive) are allowed to proceed.*

8.0 Legal Aspects of Shellfish Farming

Regulating and Several Orders

All wild or farmed scallops, mussels, clams, cockles and oysters within the territorial limits are the property of the Crown and no person can fish for or grow these species without the consent of the Crown. This consent is given through the Sea Fisheries (Shellfish) Act 1967 as amended by the Sea Fisheries Act 1968 and the Fishery Limits Act 1976 for wild fisheries, or through appropriate consent from the Crown Estate Commissioners for farming activities.

A Several Order can relate to oysters, mussels, scallops or cockles. The Order in effect grants a proprietary right of stocks of a fishery of a specific species to an individual, thus ensuring a return to a person who has 'seeded' a particular area of sea bed. It prohibits anyone fishing for or collecting named molluscan species in a designated area of sea bed.

A Regulating Order is similar to a Several Order except that it bestows on the beneficiary the right to manage and regulate a number of fisheries within a large area. The beneficiary (a group of fishermen, Sea Fisheries Committee, etc) can charge tolls and royalties in order to improve the fishery.

These Orders have only recently been extended to Scotland by virtue of the Several and Regulated Fisheries (Form of Application) Regulations 1986. SOAFD will grant and administer the Orders.

The procedures for applying for a Several or Regulating Order are outlined in the SFIA report (SFIA, 1988). Objections raised during the consultation phase can lead to a public enquiry (in contrast to the CEC consultation procedure for sea bed lease applications which operates no rights of appeal).

Scotland's first Several Order was granted to the SFIA in May 1990. Although this application went through without any objections, further proposals are expected to prove more contentious, meeting opposition from local fishermen and divers.

Other legal requirements concerning shellfish farming are either similar to those governing finfish farm developments, or are covered elsewhere in the review.

Appendix

EC Directives relevant to shellfish farming in Scotland

Directive 79/923/EEC on the quality required of shellfish waters.

Directive 91/67/EEC concerning the animal health conditions governing the placing on the market of aquaculture animals and products.

Directive 91/492/EEC (formerly Draft Directive COM (89) 648) laying down the health conditions for the production and the placing on the market of live bivalve molluscs.

Directive 91/493/EEC laying down the health conditions for the production and the placing on the market of fishery products.

A joint consultation paper entitled "National Environmental Quality Standards (EQS) for dangerous substances in water" proposing EQS for the remaining substances on the UK Red List, which do not yet have standards set, has been prepared and includes substances such as dichlorvos.

Abbreviations

ADP	Agricultural Development Programme
ASSG	Association of Scottish Shellfish Growers
CEC	Crown Estate Commissioners
CRC	Cobham Resource Consultants
DAFS	Department of Agriculture and Fisheries for Scotland (*now* SOAFD)
EC	European Community
HIDB	Highlands and Islands Development Board
IDP	Integrated Development Programme
MAFF	Ministry of Agriculture, Fisheries and Food
NCC	Nature Conservancy Council
NCCS	Nature Conservancy Council for Scotland (*formerly* NCC)
RSPB	Royal Society for the Protection of Birds
SFIA	Sea Fish Industry Authority
SOAFD	Scottish Office Agriculture and Fisheries Department (*formerly* DAFS)
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SWCL	Scottish Wildlife and Countryside Link
TBT	Tri-butyl Tin

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